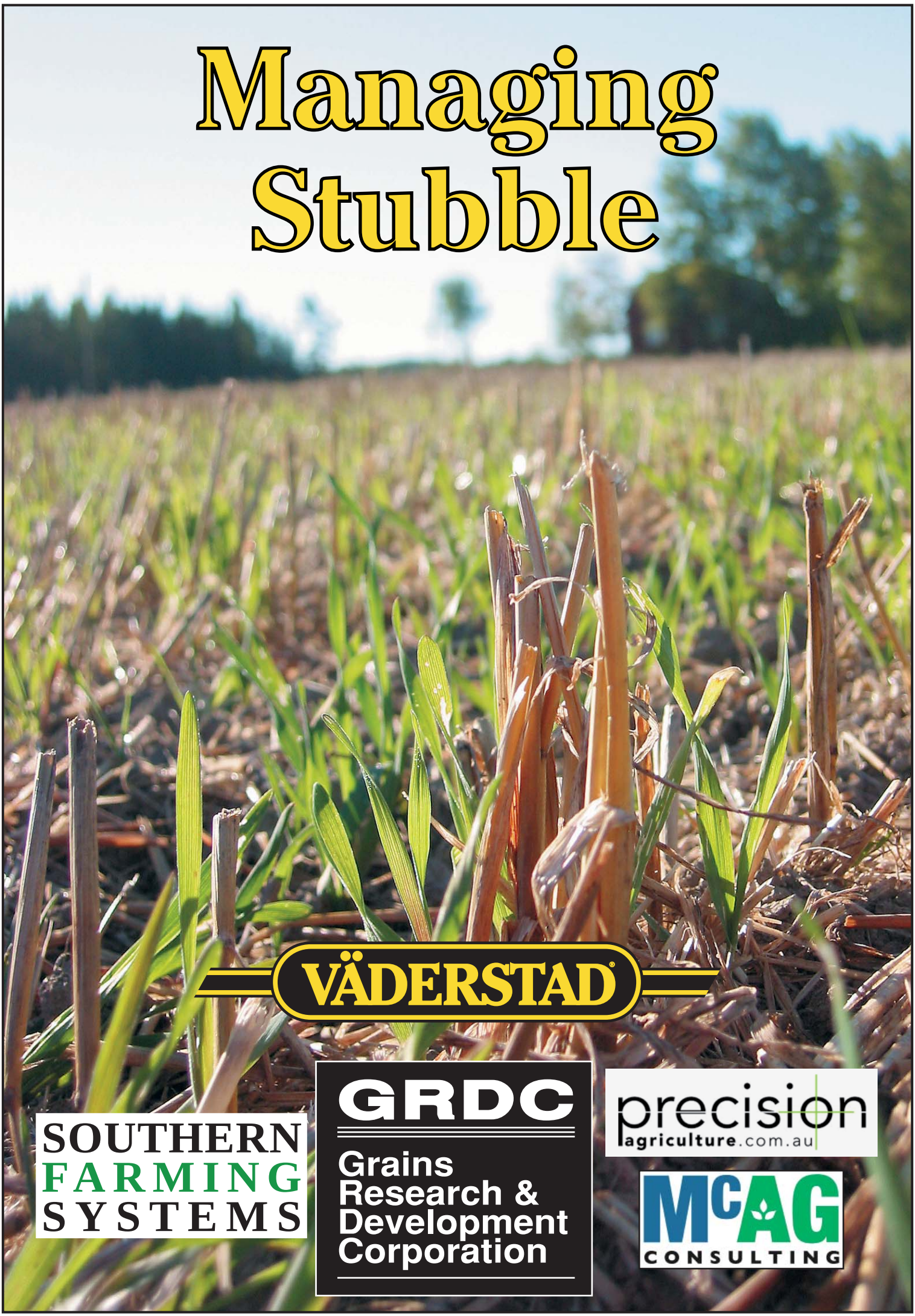
Managing Stubble



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SOUTHERN FARMING SYSTEMS

GRDC
Grains Research & Development Corporation

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Introduction

The 2010 wheat crop in Eastern Australia was above average, but was concluded with one of the wettest harvests for a long time. Many paddocks were cut very late, in far from favourable conditions. Headers and grain carts left deep wheel ruts and severely compacted soils. The decent yield meant that there were large volumes of straw to deal with, and header fronts were lifted up to try to increase harvester output, resulting in tall stubble and unevenly chopped and spread straw which could create problems at seeding time.

The aim of this booklet is to provide some information, thoughts, farmer experiences and suggestions of some of the different options available to handle the situation on your property. There is no simple fix, and it is often a compromise of time available, weather, the rotation, your farming system, the machinery available and cost.

This booklet forms part of a GRDC training initiative which will include four training workshops in Victoria and South Australia.

The details provided in this booklet are general in nature and should not be treated as specific advice. It is suggested that you seek further information from your own local sources prior to implementing change.

Chapter 1

Managing heavy stubble loads and crop residue

Jon Midwood, Southern Farming Systems

Paul Birbeck, Vaderstad

Take home messages

- There are three key stages that require decisions to be made to better manage heavy stubble loads and residue management.
    1. Harvest management
    2. Post harvest to pre sowing management
    3. Management at sowing
- Each stage can be managed in isolation and some benefits will flow from these decisions but for the maximum benefit you need an integrated approach which starts before the header is put in the paddock and continues over the summer through to sowing in the autumn.

Introduction

Symptoms of poor residue management are evident in all crop establishment systems to different degrees, whether it be conventional cultivation through to direct drilling and interow sowing. Often poor residue management problems can hide underground with the anaerobic decomposition of residue reducing crop performance or be very visual with the previous crop wrapping around tines and disc's impeding the establishment of the following crop.

Common residue problems

- Difficulties and blockages in the seeders causing down time and poor establishment.
- Stubble height and volume can both impede the progress of following passes Fig 1.
- Establishment in a dry seasons can be difficult were the straw doesn't break down.
- Sowing problems (Hair-pinning with disc drills and blockages with tined machines under adverse/ wet conditions).
- Problems with wet seasons increasing the risk of slug, snail and pest problems.
- Uneven straw and chaff spreading can lead to poor establishment leading to stunting and yellowing (resulting from reduced availability or uneven uptake of nutrients) Fig 2.
- Large volumes of residue can lead to poor weed control in crop due to interception of residual herbicides crop residue.
- Reduction in overall crop performance (Yield loss).

Figure 1 Blockages due to stubble length

Figure 2 Yellowing caused by uneven uptake of nutrients

Background

Reduced tillage and stubble retention, started 40 years ago, following development of the first knockdown herbicides. These practices meant a change from conventional cultivation, which at the time consisted of stubble burning and several passes with tines or discs to control weeds and produce a seedbed. Reduced cultivation and retained stubble led to improved soil structure and less soil erosion, and the environmental value of conservation cropping became more widely recognised. Many farmers adopted minimum tillage, which consisted of a single cultivation before sowing, generally with a tined implement followed by seeding with a combine. Conventional cultivation, involving multiple passes, had largely disappeared by the mid 1980s.

Since many of these innovations were developed, stubbles have been light due to lower than average rainfall in many areas over the last decade and hence many stubble handling methods have not been tested under higher stubble loads. The 2009 harvest produced some disappointing yields, after a very promising start, due in part to a very hot period of weather which coincided with flowering and grain fills. Stubble loads however were still reasonably high due to good rainfall during the growing season. When this heavier stubble was combined with some good summer rainfall many sowing systems, using fully retained stubble management, had significant problems with blockages at sowing and as a result large areas of stubble were burnt.

On average, many crops in NSW, SA and VIC this year will produce around 7 -10 tonnes per hectare of stubble and so the issue facing these farmers is how to manage this amount of stubble load so that it does not impact on the sowing operation, especially if they are trying to avoid having to burn?

Planning

Planning is key to residue management. Decisions per harvest, often pre the cropping season or deciding on the rotational benefit of incorporation of one crop to another can be vital.

The 3 key stages are

- Harvest management
- Post harvest management
- Management at sowing

These three key stages require decisions to be made to manage your stubbles. Each stage can be managed in isolation and some benefits will flow from these decisions but for the maximum benefit you need an integrated approach which starts before the header is put in the paddock and continues over the summer through to sowing in the autumn.

The flow chart over the page gives you some idea of the complexities of making these decisions considering the pre crop, soil type, soil structure, weed pressure, amount of residue etc

Table 1 Yields, harvest indexes and after-harvest stubble qualities

Type of crop	Various quantities harvested								
Wheat									
Grain yield (t/ha)	4.0	3.6	3.2	2.8	2.4	2.0	1.6	1.2	0.8
Harvest index	0.54	0.54	0.54	0.54	0.55	0.54	0.55	0.55	0.53
Stubble yield (t/ha)	7.4	6.7	5.9	5.2	4.4	3.7	2.9	2.2	1.5
Barley									
Grain yield (t/ha)	3.8	3.4	3.0	2.6	2.2	1.3	1.4	1.0	0.6
Harvest index	0.56	0.57	0.57	0.57	0.56	0.56	0.58	0.56	0.60
Stubble yield (t/ha)	6.8	6.0	5.3	4.6	3.9	3.2	2.4	1.8	1.0
Canola									
Grain yield (t/ha)	2.2	2.0	1.8	1.6	1.4	1.2	1.0	0.8	0.6
Harvest index	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.26	0.26
Stubble yield (t/ha)	8.8	8.0	7.2	6.4	5.6	4.8	4.0	3.1	2.3
Lupins									
Grain yield (t/ha)	2.0	1.8	1.6	1.4	1.2	1.0	0.8	0.6	0.4
Harvest index	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
Stubble yield (t/ha)	6.0	5.4	4.8	4.2	3.6	3.0	2.4	1.8	1.2
Faba Beans									
Grain yield (t/ha)	4.6	4.2	3.8	3.4	3.2	2.8	2.4	2.0	1.6
Harvest index	0.49	0.49	0.49	0.46	0.46	0.45	0.42	0.39	0.36
Stubble yield (t/ha)	9.4	8.6	7.8	7.4	7.0	6.2	5.7	5.1	4.4

The table above, taken from the November 2010 Kondinin report, gives some indication of potential stubble loads using the formula:

$$\text{Amount of Stubble (t/ha)} = \frac{\text{grain yield (t/ha)}}{\text{harvest index}}$$

- Stubble chop length is determined by:

- The type of crop being harvested (Canola v Cereals)
- Cutting height (quantity of material going through the header)
- Straw moisture content (weather, time of day, how ripe)
- Forward speed (amount of crop flow through header)
- Topography of paddock (going up slopes takes more power = poorer chop)
- Degree of straw laceration, it helps the soil microbes attack the straw surface which in turn speeds up decomposition. For this reason some grower fit serrated knives to their combine straw choppers, not only does it reduce maintenance (sharpening) but also aids residue breakdown.

Straw chop length	Time to decompose
Milled to 1mm	14 days
0.5cm	29 days
1cm	30 days
2cm	47 days
5cm	54 days

Source: Harper

- Spread of straw and chaff and height of stubble
- With very heavy stubble loads or the need to harvest more area in less time the stubble height can be increased with the option to mulch the paddock later as a separate operation. It's estimated a drop in the combine header front height from 30cm to 15cm will only reduce output by 20% on the best case scenario and up to 60% in the worst case scenario.

Choice of cultivation system - on each field

This scheme is meant as a way to find out what cultivation method that is most suitable on each field. By considering the precrop, soil type, soil structure, weed pressure, amount of plant residues etc, an advice for each field can be extracted.

START

Is the pre crop good or bad in relation to the crop that will be drilled?

(Generally a crop of another species is a better precrop than one of the same species.)

Good

What is the dominant soil type?

Lighter soil

How is the soil structure?

Good

How is the distribution of plant residues?

Worse/High amount

Good/Small amount

Not so good

Cultivate the soil more deeply. !

Heavier soil

How is the soil structure?

Not so good

Is the main problem the forming of tracks?

Yes

No

Good

How is the distribution of plant residues?

Worse/High amount

Good/Small amount

Not so good

Is there a lot of crop residues?

No

What is the dominant soil type?

Lighter soil

How is the soil structure?

Good

Are there a lot of weeds or weeds difficult to control?

Not so good

Cultivate deeply or burn. !

Heavier soil

How is the soil structure?

Not so good

Cultivate deeply. Growing of catch crops or fallow might improve the soil structure. !

Good

Are there a lot of weeds or weeds difficult to control?

Yes

Cultivate deeply or burn. !

1. Precrop

2. Soil type

3. Soil structure

4. Weed pressure/ plant residues

Can the crop residues be distributed by a straw harrow? If so: go to Good/Small amount.

Otherwise you should work the soil more deeply.

Are there a lot of weeds or difficult weeds?

Yes

Burn.

No

What yield level do you expect?

Normal or high

Use direct drilling or shallow cultivation

Low

Use direct drilling

Work the soil deeper at least in the wheel-tracks.

Work the soil deeply. Growing of catch crops or fallow might improve the soil structure.

Can the crop residues be distributed by a straw harrow? If so: go to Good/Small amount.

Otherwise you should work the soil more deeply or burn.

Are there a lot of weeds or difficult weeds?

Yes

Burn.

No

What yield level do you expect?

Normal or high

Use direct drilling or shallow cultivation

Low

Use direct drilling.

Use deep cultivation or burn.

Yes

No

What yield level do you expect?

Normal or high

How much risk could you accept?

Higher risk

Shallow cultivation. Consider early fungicide treatment.

Low risk

Work more deeply. Consider early fungicide treatment.

Low

Use direct drilling. Consider early fungicide treatment.

If the weeds can't be controlled the field should be cultivated deeply or burnt.

If possible control the weeds with glyphosate/ cultivation

Yes

No

Yes

What yield level do you expect?

Normal or high

How much risk could you accept?

Higher risk

Use direct drilling. Consider early fungicide treatment.

Low risk

Work more deeply. Consider early fungicide treatment.

Low

Use direct drilling or shallow cultivation. Consider early fungicide treatment.

- If retaining the stubble the rule of thumb used to be; stubble height should be equal to row spacing. However most people are seeing the benefits of cutting as low as is econom ically practical and getting the spread as even as possible across the full cutting width.

- Stubble height is less of a concern if you plan to burn, but accurate spreading of the lighter chaff is still very important.

- In a number a paddocks the header trails have shown up from the previous harvest where extra stubble has been concentrated or more particularly extra chaff. These areas have often been higher yielding from the extra organic matter allowing for better mois ture retention and possibly nutrition.

- Break crops such as oil seed rape and pulses can create a high loading on the combine harvester's sieves which will in turn lead to high concentrations of material being win drowed behind the harvester.

- The chaff created by a high yielding wheat crop can be a greater challenge than the straw. Wheat chaff falls to the base of the stubble and can hold large amounts of moisture which will impede the soil drying in a wet season not to mention encouraging slugs.

- If you are using a contract harvester make sure the header has a good straw chop per and that the stubble is cut to the height you want.

- Work has been carried out at Agricultural Machinery Research and Design Centre, University of South Australia looking specifically at the relationship between stubble height, machinery design and potential modifications to improve stubble flow.
  Their work shows that stubble height should be kept to 60-65% of the effective tine clear ance, in short the clearance between the ground and the first major obstruction on the tine or shank (Jack Desbiolles).

- Windrow for burn or bale
- Placing the straw in a windrow for baling allows faster harvesting and removes straw from the paddock. This obviously helps with minimizing residues that may create issues at sowing.
- Depending on type of straw chopper it may still place all the chaff in a windrow rather than spreading it.
- Burning windrows may not be successful following a wet summer or if you wish to graze the stubble.

Harvest Management

Pre harvest and harvest management decisions are perhaps the most important decisions to effect the following operations. However often in the rush of harvest these are overshadowed by harvesting decisions based on weather and maintaining the quality or moisture of the current crop.

- Remember the requirements for the following crop
- Canola and Pulse stubbles present less of a problem to sow into compared to a heavy wheat or barley stubble
- What are the likely pest problems in establishing the next crop? E.g. Slugs or snails in Canola
- Do you have a grass weed problem that relies heavily on the use of residual herbicides applied pre sowing?

Barley following wheat

Canola following wheat

Beans following mustard cover crop

- What is the crop and stubble load?
- Shorter straw length varieties have less biomass to handle
- Use of PGR's may be required
- Assessment of the likely stubble load will guide you as to which technique maybe the most suitable. The threshold where problems can start to occur with machinery being able to handle the stubble is 3 – 4t/ha.
- Stubble breakdown is largely determined by both soil moisture and temperature. If there is good soil moisture at harvest then this provides the best environment for breakdown during the summer.

Pre Sowing Management

Though harvest 2010/11 has run later than normal in most states there is still in most cases a minimum of 8 wks between harvest and sowing. In a normal season this could be a maximum of 16 weeks. Weather permitting this does give plenty of time to mange the previous crops stubbles before sowing and do as much weed control out of crop as possible.

- **Burn**

Advantages

- Early or late burn. Leaving burning until just prior to sowing is seen by some as a com promise, whereby stubbles are retained over the summer to maximise moisture reten tion but they can still remove the burden of a large stubble load.
- Soil Organic Carbon will decline faster than in retained stubbles.
- There is a large loss of nutrients from the straw when it's burnt (Table 1).The losses of 82% of N and 74% of S are reasonably consistent across a number of different trials.
- There is more variation in losses of P, K, Ca and Mg which is mainly as ash. This would be both as airborne ash and due to subsequent wind and water wash, removing ash from the paddock.

Table 1: Stubble nutrients and amounts lost from a hot burn (for a wheat crop – yielding 5 t/Ha, produces 7.5 t stubble per Ha)

	Nutrient	Amount
Amount nutrients in stubble (kg/Ha)	N	56
	P	5.9
	K	109
	Carbon	3450
Amount lost during a hot burn (kg/Ha)	N	46
	P	2.6
	K	44
	Carbon	2760
Percentage lost (%)	N	82%
	P	44%
	K	40%
	Carbon	80%
Amount fertiliser to replace lost nutrients (kg/Ha)	Urea	100
	Single Super	30
	Muriate of potash	87

Disadvantages

- Burning stubble, rather than retaining it, reduces the carryover of diseases and pests to subsequent sensitive crops. The temperatures achieved in a stubble fire influence the ef fectiveness of this technique.
- Burning is the cheapest and most convenient way to remove large amounts of stubble. But burning is facing more opposition and regulations as air pollutant levels increase. In NSW, the Environmental Protection Authority (EPA) has access to legislation to control burning if necessary. In the short-term the EPA is pushing for the adoption of best man agement practices for burning but the longer term goal is for farmers to use alternative methods.

- **Bale**

Advantages
- Faster harvesting as no need to use straw chopper
- Removes straw from the paddock easily regardless of stubble load. This obviously helps with minimizing residues that may create issues at sowing.

Disadvantages
- Soil Organic Carbon decline faster than retained stubble management
- Loss of nutrients from the paddock (see Table1 – amount of nutrients in stubble)
- Potential for additional compaction from baling operation and loading trucks in the paddock

- **Retain**

Advantages
- Soil Organic Carbon decline is slower than when stubble load is controlled with burning or baling. The greater SOC may contribute to better structural stability and water infiltra tion in the soil surface and greater earthworm populations.

- Less erosion by rainfall and wind. The adoption for no till and fully retained stubbles has be very high in WA. This has been due to the very high potential for wind erosion on the lighter soils and the relatively low stubble loads.

- Stubble also increases soil moisture retention, particularly in the surface soil pre-sow ing and in early crop development (M Poole, 1987). This has been important during the recent run of dry seasons by maximising the plant available water for sowing in the low to medium rainfall environments.

Disadvantages
- There can be problems with crop emergence and early growth, which have been at tributed to allelopathic effects of the straw breaking down, lower soil temperature under a cover of stubble and shading of the emerging crop.

- Stubble retention can lead to disease carry over from stubble to the newly sown crop, effective application of herbicide may be impeded, and nutrients may be immobilised.

- Stubble retention systems rely far more on herbicide use for weed control and this has led to a problem with herbicide resistant weeds, particularly annual ryegrass, wild oats and wild radish.

- Use of integrated management recommended for control of resistant weeds includes considering a reversion to some cultivation and the use of stubble burning

- No means of rectifying compaction or soil structure issues, especially after a wet harvest.

- **Graze**

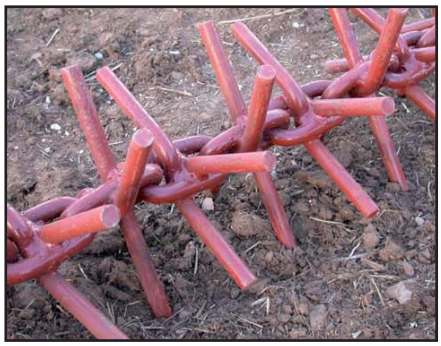
Advantages
- Provides a source of summer feed
- Helps keep some summer weeds under control
- Heavy grazing can help break up the stubble and start the decomposition of the straw

Disadvantages
- During wet conditions the topsoil can become poached if grazing management is poor and overgrazing can leave soils prone to erosion.
- Stock camps and walking tracks to water are very prone to compaction.
- With long stubble stock can often fold the straw down and leave it complete to wrap around tines in subsequent sowing operations

- Mulch

Advantages
- Mulched stubble may slow evaporation during the early growing season (before canopy closure) and improve water availability to crops on wider rows.
- Mulching is used to break lengths of straw into smaller pieces, increasing the rate of breakdown and reducing the problems of trash flow at seeding.
- Allows the option to increase stubble cut height to harvest more area in less time with heavy stubble loads.
- There are a wide range of methods used to mulch crop residues:
  Harrows - knock stubble over and break some of the straw into pieces. If done soon after harvest it can increase the rate of stubble breakdown, providing there is rainfall to aid the process.

- A prickle chain - it can be used in the same way as a set of harrows but is slightly more aggressive.



- A disc chain - a series of discs linked together and is used to smash stubble. It is quite aggressive and will cut out summer growing weeds.
- A flail mulcher–a PTO driven set of flails attached to a central rotating shaft, used to smash straw into small pieces.

- The Stubble Cruncher is an implement designed to knock down and cut stubble to reduce the length of the straw and increase the rate of breakdown. The rear roller hav ing a cutting action on the straw lying on the surface
- The Trash Cutter lays stubble down across the front of self-sharpening coulters which cut and evenly spread the trash. The stubble is cut into short pieces and left on the soil surface.

From Cereal Stubble Management 2009 - Murrumbidgee Landcare Inc.

Disadvantages

- Relies on dry and brittle stubble to chop the straw into smaller pieces
- Can be expensive, time consuming and requires another pass over the paddock.
- Limited or no incorporation into the soil

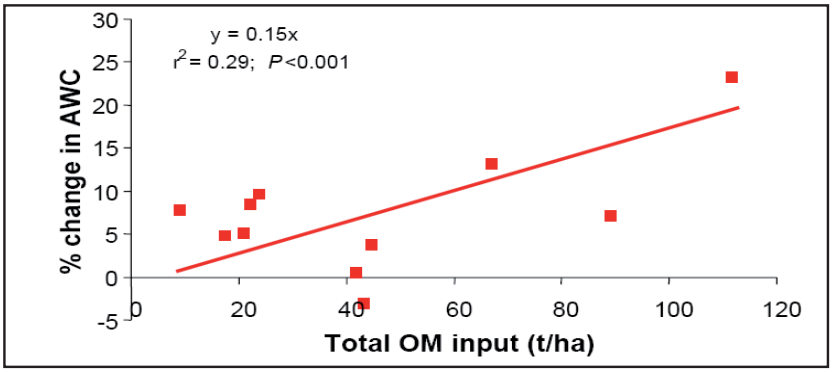
- **Incorporation**

When looking at using incorporation to manage crop residue it is important to remember it is just one of the elements to be considered, the actual system to be used will be dependant on the complete cropping system. Long runs of high yielding cereals where the straw is incorporated will be more difficult to manage than a cropping system based on first wheats following a broad leaved break crop.
Most growers recognise that a balanced rotation is essential for the long term health of the soil. However economics are often a greater driving force, and it has to be recognised that short term profitability probably figures higher on the list of most farmers, than the environmental implications. Because of these cost many people are considering working with incorporation rotationally, working white cereal stubbles in before sowing Canola and subsequently direct drilling the following cereal into Canola stubble.
With the Canola crop which by its nature is a lazy rooter benefits from the previous crops incorporation especially with ripping will allow it to achieve better deeper rooting. The subsequent cereal crop direct drilled or sown after incorporation will be able to benefit from the work the canola plants tap root has done.
From a crop residue management view-point, particularly if using a mixture of incorporation and direct drilling, a cropping system based on alternating cereal and broad leaved crops has the most to offer; Rotation of fragile and non fragile residue gives you

- Varied quantities of residue
- Residues with different carbon/ nitrogen ratios
- Different drilling and harvesting dates
- Longer inter-crop periods allow improved residue decomposition.

In the short term excessive crop residue can be classed as a nuisance, but in the longer term it becomes an asset. Higher levels of organic material in the upper layers of the soil structure have numerous benefits including:

- Improved soil structure, resulting from increased earth worm activity.
- Improved water infiltration and water holding ability.
  leading to reduced runoff and off-site pollution.
- Improved workability and traffic-ability of difficult soils.
- Carbon storage.
- Increased biological activity and increased nutrient availability.
- Better rooting for the subsequent crop.
- Maximum decomposing of the stubble from better soil to straw contact and earliest opportunity to start the process off.
- Creation of stale seedbeds to encourage weed seed germination.
- Consolidating seedbeds after cultivation to minimise moisture loss, reduce the risk of capping and maximise soil contact with both stubble and weed seeds.
- Opportunity to rectify structural problems in one pass.
- Allows for incorporation of Lime and Gypsum.



Graph showing the effect of organic matter inputs on topsoil Available Water Capacity (AWC)

Source: DEFRA funded soil QC project and Andrew Richards, Masstock Arable.

Shallow Incorporation - Vaderstad Carrier

Working on the basis of only 1cm of cultivation depth is required for every t/ha of crop residue, we are not aiming to turn the earth brown as with a conventional cultivation. The aim with a shallow incorporation pass with the Carrier is to stitch the crop residue into the top aerobic layer of soil (top 8cm) and reconsolidated it to get maximum soil to straw contact. The stitching effect rather than burying allows the soil to hold some structure and not stops it from blowing, it also allows easy moisture capture from summer rains being softer than the undisturbed surface.

Stubble straight after the Carrier, Feb 2010

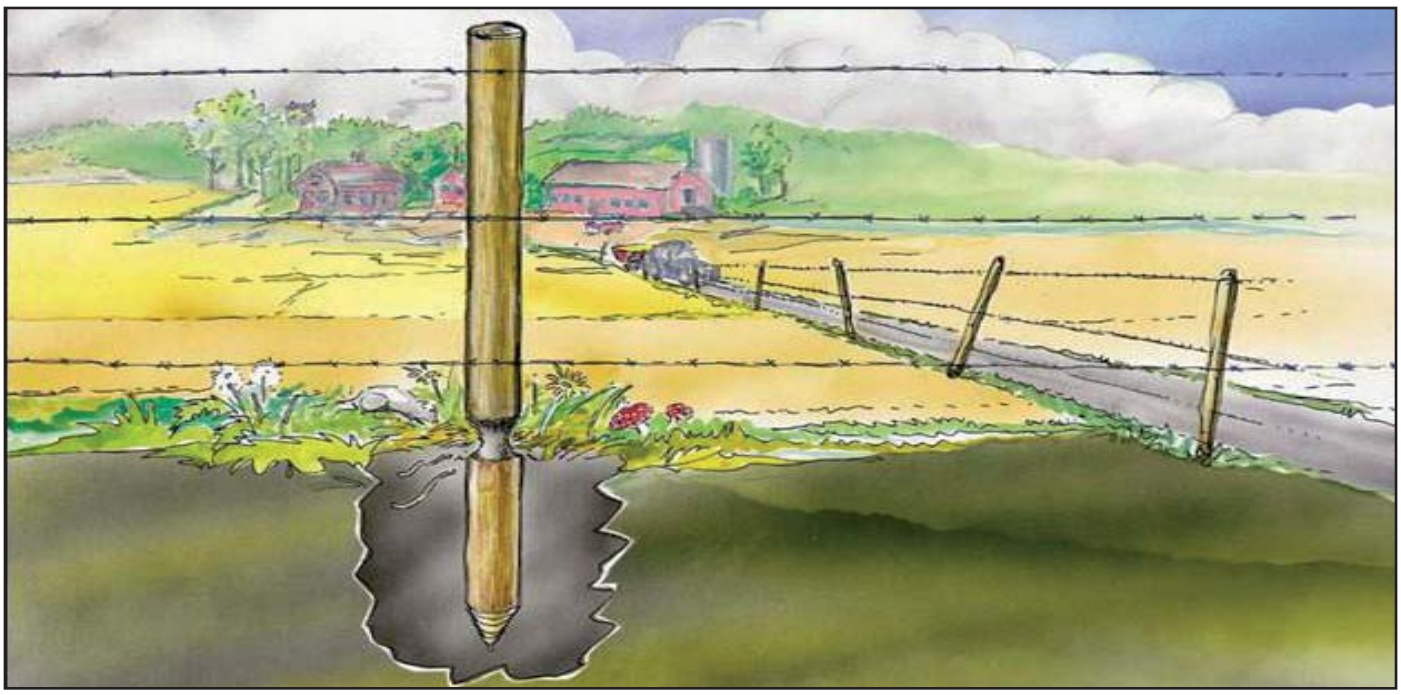
Stubble a few weeks after the Carrier

Wider working widths, higher speed passes

One of the big advantages of shallow tillage is large widths of machines can be pulled at higher speeds (12-15 kph). Working with a pair of conical discs closely spaced means that as the Carrier discs cut through the surface they mix the soil and residue through the full working depth. More conventional offset concave discs with wider spacing are more likely to bury the residue rather than mix through the whole profile, leading to slow straw breakdown and more risk of erosion.

Keep the residue in the aerobic layer

By keeping the residue in the top surface this allows maximum break down. An easy way to see this is how a wood fence post will rot off at surface level. The top exposed gate post will dry and weather, and take as many as 10's of years to rot, the lower section below the earths surface will remain wet but relatively well preserved with no oxygen for microbe to live. The area just in contact with the soils surface has Oxygen, moisture and microbes to break the residue quickest and in this case rot the gate post.



Balancing the nutrition

With cropping to avoid problems such as nitrogen lock-up and the allelopathic effect in the following crop which can occur when incropetaing large volumes of straw, timing is critical.

The micro-organisms that are responsible for initial residual breakdown generate organic acids and natural chemicals or toxins from related plant types that inhibit germination and growth of the next crop. In the presence of moisture there is an initial rise in this allelopathic effect which then declines after approx. eight weeks (Elliot 1978). By incorporating the straw immediately after harvest the maximum time is available for straw breakdown and a subsequent reduction in the allelopathic impact on the establishment of the following crop.

The higher the organic matter, therefore carbon content, the quicker the soil can break the residue down due to an increased level of nutrients and micro organisms. Soils low in organic matter / carbon will take much longer to break residue down and are more likely to need additional nutrition with incorporation (Kirby 2011). It is not unusual for farmers to see immediate structural improvements and greater water holding capacity from incorporation, however, nutritional benefits can take as long as 3 - 5 years to start cycling. The use of break crops with more brittle residue can speed this process up.

Consolidation not compaction

With all incorporation systems timely reconsolidation of the soil is also essential not only to reduce moisture loss, but to re establish capillary action in the soil. The capillary action is important both in wet and dry soils, in wet soils allowing drainage and dry soils allow the capture of any moisture. The greater the depth of cultivation the heavier the reconsolidation will need to be. The ribbed press on the Carrier leaves a distinct profile ideal for rain capture and minimal blowing.

Carrier stubble prior to spraying after 8 weeks breakdown

In the majority of cases one pass with the Carrier will be sufficient to get a good enough mix with up to 70% of the straw still present on the surface. A second pass is often more cosmetic and can give a better consolidation but should only be carried out if really necessary.

With increased organic matter in the topsoil, the soils water holding ability becomes far greater, the nature of mechanical soil disturbance also leads to great nutrient availability even if some has been used in the straw breakdown process. For these reasons drainage and deeper structure becomes more and more important as the topsoil improves. With a poor and compacted layer below the soil a plant will not be able to reach further for nutrition and it's potential will not be reached.

Shallow incorporation with deep ripping

One option is to work the Carrier in conjunction with a deep ripper. Working with a Yeomans plough or similar machine does allow the operation to be carried out by a smaller tractor and followed by the Carrier to level the top and mulch the surface.

To reduce the number of passes the two operations can be carried out in one pass with the Top-Down. The front discs are the same as the Carrier and they mulch the top 5 to 8cm and the following tines work down as deep as 30cm to improve subsoil disturbance and drainage.

Often compaction has remained in the soil for a number of years. The pictures below show damage that was created by a one way plough many years ago. Even though the ground has been direct drilled for nearly ten years, the damage still remains.

Even in the marginal season of 2009 this farm saw an improvement in yield by 16% following the TopDown, but more importantly the long term pan was removed for subsequent crops.



Disadvantages

- Capital cost of machinery
- Limited choice of suitable machinery designed specifically for the job
- Limited understanding of using this technique.

OPTION	BENEFITS	DISADVANATAGES	COST /ha Including tractor/driver/diesel
Direct Drill	One pass, simple	Not as much chance for weed control, stubble loads can limit machines and t/ha yield	$ 45-50
Flail mulch	Good mulch speed	Extra pass	$ 30-40
Straw harrows	Big widths, high output.	Timing critical, suitable for dryer seasons	$ 25-35
Prickle chain	Width, quick, good for weed germination	No consolidation, can still leave long straw lengths	$ 30-40
Stubble Mulcher	Width, quick	No consolidation, often no straw cutting stubble can blow	$ 30-40
Shallow Mulch	Good widths and outputs	Timing critical, more attention to detail needed	$ 40-50
Deep Mulch	Opportunity to do structural work	More expensive	$ 60-80

Sowing Management

- *Wider row spacing, Inter row sowing*

  Advantages
  - In order to cope with high stubble loads, an increase in row spacing may improve sowing operations by improving trash flow through sowing machinery and reduc ing the risk of blockage. There is also an additional advantage in that tractor draft is reduced.
  - Broadleaf crops appear to suffer no yield loss, or even may gain a slight yield by widening row spacing beyond 18 cm.
  - Ability to use herbicides incorporated by sowing at higher rates
  - Faster sowing speeds possible
  - Lower cost of machinery for a given width.
  - Inter row sowing can also be adopted if guidance is an option, to limit the impact of stubble on establishment. This can be further enhanced by the use of Controlled traffic farming to minimise general compaction.

  Disadvantages
  - Cereals show a reduction in yield with increasing row spacing, irrespective of the stubble management approach used, in all but the low yielding situations (yields <3.5t/ha)
  - Inter row sowing difficult on slopes
  - Crop is slower to achieve ground cover which impacts on the crop competition with weeds.
  - Increased chance of moisture evaporation from the soil
  - Fertiliser placement important due to potential toxicity problems

- *Tines*
  - Cheap and an easy option but they don't handle as much stubble as a disc seeder and require more horse power for a given width.
  - They offer excellent incorporation and safety of pre emergence herbicides
  - Water capture in the seed furrow
  - Opportunity to add some cultivation below the seed. Seed and fertiliser can also be delivered separately into the seeding row.
  - Narrow knife points with less than full cut out are required.
  - Press wheels use provides in furrow packing to both improve germination rates and to consolidate the integrity of furrows for water harvesting.
  - Press wheel width should be as wide as the seed band, and slightly wider than the natural furrow produced by the seeding boot.
  - Stubble residue managers can be worth fitting to the seeder. Examples of resi due managers include stubble tubes, row cleaner wheels, and disc coulters.

- *Discs*
  - Ability to minimise soil disturbance
  - Generally precise seed placement
  - Limited burial and stimulation of weed seeds
  - Faster sowing speeds
  - Reduced fuel usage due to lower draft
  - Lower tractor horse power requirements
  - Ability to retain stubble on top of the soil surface
  - Handling of rocky paddocks

From WANTFA

Case study 1

The farmer Scott Chirnside of Chirnside Agriculture Pty.Ltd. has been working with the Vaderstad Carrier shallow mulch approach post harvest for the past three seasons. The 2 400 hectares large property in Victoria is largely based around cropping and at this time has a rotation that includes canola, wheat and barley.

Scott also currently runs 350 Angus Cows with calves plus 100 joined heifers and turn's out steers to feedlots annually in August. Normally in most years the stubble feed in January until May is very valuable to the farm.

However constant concerns not to graze cattle on wet stubble paddocks because of compaction fears and means that to date in 2011 minimal grazing has taken place given the huge rainfall that has been received (160 mm in January 2011 alone) on top of a wet December.
Scott decided to stop burning straw a few years ago and wanted to incorporate straw into the farming system. "Mainly from a sustainability point of view, throwing away organic matter is not sustainable and it is inevitable that the burning must stop" he says. Today, he is predominately working his Vaderstad Carrier into stubbles post harvest to encourage the straw to rot down, and get a good control of volunteer weeds.

"Initially the plan was just work the wheat stubbles going into barley; this would give us much better control of volunteer wheat. However seeing the benefits this has had to these paddocks we moved on to work all the stubbles as soon as possible post harvest, this allows us to get maximum stubble breakdown, volunteer and grass weed control".

“Keen to follow as much of a controlled traffic approach as we could, we started off working with the direction of cropping, however we found far better results working at 30 degree to the previous stubble. This allowed better mixing and a great ability to spread chaff trails and leave a more level finish. Ultimately I don’t believe this has been to the detriment of the soil as we are travelling on firm ground and getting a better mix, a leveller paddock and better conditions to sow into with our Simplicity Bar’.

This seasons testing harvest will require some deeper remedial work to be done and Scott anticipates deep ripping some of the worst affected paddocks and using the Carrier afterwards to level up the ground. He is also thinking of doing this rotationally perhaps in front of the Canola to improve the sub soil structure and get deeper rooting.

The farmer is very satisfied with the job that the Carrier does and says, “It is possible to use the machine even in the summer without a dust problem, because of the heavy roller reconsolidating the stubble and soil mulch. The ribbed mulched surface left behind is perfect for catching the summer rains and keeping soil moisture. We have used the machine on stubble in January 2010 and had massive wind storms a day or so later with no lifting of the soil whatsoever which was a big bonus compared to neighbouring sheep grazed and bare paddocks.”

Scott only use’s a smaller 5 metre Carrier so he can use it on his smaller John Deere 6630, allowing the bigger Caterpillar Challenger to do other work. With 3 sections the Carrier can contour well over rougher conditions and is equipped with rubberized individual disc suspension to cope with the stony paddocks.

“At 5 metre width doing an average of 12 km/h we still achieve around the 5 to 6 hectares an hour and the fuel consumption stays around 17-19 litres per hour while working at the shallow setting” commented Scot. “Working the machine at deeper settings which is rarely required can increase fuel consumption by around 10 litres per hour”

In addition to being able to operate at a speeds of 10-12 kilometres per hour, the main reason for buying a Väderstad Carrier was its high quality, strength and rubberised suspension bearing units giving it protection in tough working conditions.

Case study 2

David Jamieson, manager at Bolac Plains in Victoria changed from direct drilling system to mulching and deep ripping type system in 2008. Managing the family property David crops 900 ha's of Wheat, Barley and Canola. The mixed operation also runs 2500 Sheep grazing on grass and Lucerne paddocks which are often over sown with spring barley or wheat for extra winter feed, Duel cropping pads, with the opportunity of grazing during the winter and preparing for harvest in the late spring summer. After harvest the Lucerne bounces back very quickly; Using the Grain and Graze format to maximum production.

Similar to many farms in the area the cropping is to a larger extent on raised beds to reduce water lodging. The majority of the soils are clay which has an underlying seam of a buck shot stone, which in the past has been the biggest restriction .to rooting.

David used a Vaderstad Topdown to make the change of approach, when asked why he commented "There was heaps of phosphorus and potash in the stubble after harvest that we weren't getting the benefit of we might as well put it into the soil. Increasing herbicide resistance and my increasing reluctance to continue burning stubbles were also major factors". David says he appreciates how the Top Down, more specifically the System discs incorporate stubble and its ability to deeply rip into the settled clay and buck shot, which is giving him a greater depth of soil to now grow his crops in. He says, "The rear press rings are the key to re-consolidate so the soil straw mulch, can get good activity in the ground to breakdown, also this encourages the re-growth of volunteers and ryegrass straight away".

" The deep ripping tines have shown advantages in the past 2 seasons allowing the roots to get down, but with this years tough harvest conditions they will do a great job in repairing harvester and chaser bin damage". "We would normally try and chase the harvester out of the paddock with the Topdown to get maximum affect, but labour and the conditions haven't allowed us so far, when harvest is finished we plan to get straight back into the paddock with the Top Down".

David agrees timing is the key to get the stubble and residue to break down “the sooner we can return the straw and residue into the top few inches of soil the sooner we start rebuilding organic matter”. “In the first season we were a little bit underpowered and worked later than we would have liked. In 2010 we didn’t wait so long behind harvest and with a bit more power and greater ripping depth it proved to be a winning combination”. Upon reviewing the stubble height of 2008, Bolac Plains made considerable effort at harvest to maintain the stubble height around 25cm, worked out to cost an extra $10.00 Ha at harvest over the cereal stubbles that where to be TopDowned.

The combination of the farms Topdown post harvest and the farms existing 6m combine seeder has presented few problems sowing all the farms cereal crops. For the 2010 season David bought a Bio-drill to fit on the Topdown to sow Canola and fodder rape, and says, “The calibration is very accurate and the early sown canola emerged very well, the distribution is excellent”. Like many farms in the area the Canola has been hit the hardest by the wetter growing conditions for 2010, of 350 Ha’s 30% washed out and to add to the difficulty, windrowing proved to be very difficult, the crop that was left had great potential but yielded 1.5 t/ha; the establishment we had of the spring fodder rape has been very pleasing.
Wheat yields have averaged very well, given the weather conditions, but test weights are down, averaging 5.5/ha per Ha for 2010.

“The most fascinating thing about the Topdown is its ability to do everything in one pass - it not only saves money, time and fuel but also enhances the soil condition. Previously, it would take three passes to do the same job that the Topdown does in one go”. But also enables the ability to manage stubble to prepare the following season.
I’m always asked the question in relation to the cost benefit of a machine like the Vaderstad Top-Down, What $ will it return in the first year?

I find it to be a very difficult to give a direct answer, at Bolac Plains, we were looking for a machine that would incorporate stubble, cultivate, deep rip, consolidate, renovate and build raised beds and sow, The TopDown ticked all the boxes and given the backup and support, I’m very pleased with the results.

Chapter 2

Stubble Management in a No - Till System with a focus on high rainfall zones

Andrew Witlock, Precision Agriculture

Matt McCallum, McAg Consulting

Introduction

The advent of affordable 2cm autosteer for broadacre farmers is an exciting development in Australian agriculture. It allows farmers to sow crops with a high level of precision never thought possible before GPS. Inter row sowing is rapidly being adopted by no till farmers across Australia. Inter row sowing refers to the sowing of crops precisely (-/+2cm) between the previous years crop rows. Over the last five years a number of research trials and farmers have discovered a number of agronomic benefits associated with inter row sowing.

There are many potential benefits of no-till including:

- Increased water storage through better infiltration;
- Increased cropping opportunities through more stored soil water;
- Potentially higher yields as a result of more plant available water;
- Lower costs with less field operations;
- Better timeliness of operations;

However, managing high stubble loads (>5t/ha) in no-till is a particular challenge for farmers in high rainfall cropping zones. This booklet aims to help provide farmers with techniques to aid in the retention of stubble.

Many farmers believe that no-till starts with the planter/seeder, which is NOT the case. In some instances, we have seen no-till fail because people haven't considered the whole system. Row spacing and stubble management are fundamental aspects of the no-till system.

This chapter is comprised of six sections covering the key aspects for stubble management in no-till systems, with a focus on the high rainfall cropping zones of Australia:

1. Understanding the likely Benefits of Inter-Row Sowing
2. GPS guidance requirements & Tyne Arrangements
3. Practical Guidelines for Inter-row Sowing
4. Managing Stubbles at Harvest
5. Herbicide Management in Heavy Stubbles
6. Crop Management for wider row spacing
7. Farmer Experiences with Stubble Management

Section 1: Understanding the likely benefits of inter-row sowing

Reasons for considering wider row spacing (250 – 375mm) and inter-row sowing into standing stubble include:

- Improved handling of heavy stubble loads at sowing,
- Avoidance of soil-borne diseases in cereals,
- Improved harvestability and reduction in disease incidence in legume crops,
- Retained standing stubble offers protection against impact of wind, rain droplets and sun,
- Improved sowing efficiency, seed placement and crop establishment,
- Opportunities to reduce use of chemicals through banded and shielded spraying,
- Improved pre-emergent soil applied herbicide efficacy,
- Reduced tillage and promotion of soil health.

Yield Increases for Wheat-on-Wheat

Yield increases for wheat-on-wheat sowing into standing stubble were measured on 7 out of 10 sites over 4 years (Table 1). In 3 of the sites less soil-borne disease on the inter row was a significant factor in increasing yields. Better plant establishment and possibly an improved micro-climate for wheat in standing stubble also contributed to a yield improvement for inter row wheat in standing stubble.

Table 1 Wheat-on-wheat yields in inter row sowing experiments 2004 to 2005

Site	Sowing Row	Yield t/ha	Yield difference	Disease effect
Sandilands SA 2004	inter row	4.11	0.23	Take all
	to row	2.88		
Tamworth NSW 2004	inter row	2.52	0.22	Crown rot
	to row	2.30		
Sandilands SA 2005	inter row	3.74	0.32	CCN and Take all
	in row	3.42		
Hart SA 2005	inter row	2.99	0.22	None
	in row	2.77		
Average all sites	inter row	3.34	0.25	8%
	in row	3.09		

Harvestability Benefits for Inter Row Lentils

From trial data and farmer experience, there appears to be significant potential advantages in the harvestability of inter row lentils sown into standing stubble (Tables 2, 3 and 4). Lentils plants sown into standing stubble were taller (up to 8cm) and the height of the first pods was also greater by (up to 5cm) compared to burnt and slashed stubble. Increasing the height to where the first pods develop and by the lentils using the stubble to "lean on" at harvest time will prevent less lentils lying over onto the ground. This can result in less harvest losses by physically being able to pick up more lentils with the harvester front, and also increase harvest speeds by having the harvester front higher from the soil surface. Indeed, farmers are finding they can reduce harvest losses by 0.2 - 0.4 t/ha in some cases and one farmer doubled his harvest speed in an on-farm trial of inter row vs. in row lentils. There appears to be little yield advantage of inter row sown lentils in dry years (tables 2, 3 and 4), but yield increases of up to 0.5t/ha at Mallala in South Australia were measured in an above average rainfall year (2010). The reason for this is yet to be determined.

Table 2 Stubble and row spacing experiment for lentils at Sandilands, SA 2006

Stubble	Row spacing (cm)	Yield (t/ha)	Crop height (cm)	Height to 1st pod (cm)
Burnt	22.5	0.58	23.8	14.6
Slashed	22.5	0.55	25.7	16.1
Standing	22.5	0.58	31.4	20.2
lsd 5%		ns	3.3	1.1

Table 3 Stubble and row spacing experiments for lentils at Horsham, Vic 2008

Stubble	Row spacing (cm)	Yield (t/ha)	Crop height (cm)	Height to 1st pod (cm)
Slashed	19	0.20	19.9	15.2
Slashed	30	0.20	20.8	16.1
Standing	30	0.26	23.2	17.9
lsd 5%		0.05	0.7	0.7

Table 4 Stubble and row spacing experiment for lentils at Dimboola, Vic 2007

Stubble	Row spacing (cm)	Yield (t/ha)	Crop height (cm)	Height to 1st pod (cm)
Slashed	19	0.51	18.4	7.6
Slashed	30	0.62	19.6	9.3
Standing	30	0.66	19.5	9.3
lsd 5%		0.10	1.1	0.8

Section 2: GPS Guidance Requirements & Tyne Arrangements

If you are serious about inter-row sowing, a ±2 cm RTK system with your own base station or a Continuously Operating Reference Station (CORS) Network is the way to go. This is because repeatable accuracy enables your sowing rig to come within ±2 cm of your sowing rows from the previous year and be able to hold a straight line down the length of the field. Sub-metre autosteer (±10-30 cm) does not have this level of repeatable accuracy, but you can re-set your A:B line by eye and attempt to inter-row sow the following year. However, this will not be as successful as a ±2 cm system. Also, owners with sub-metre systems will allow for some overlap to compensate for the lower level of accuracy in the system. This results in an uneven row configuration across the field. From farmer experience, an estimated success rate for inter row sowing with various systems is as follows,

- Up to 90% for ±2 cm RTK system with your own base station
- Up to 70% for sub-metre autosteer (±10-30 cm)
- Up to 50% by eye using permanent wheel tracks

Some rules to follow for inter-row sowing:

- The base station must remain at the same location for a particular paddock year-in year-out.
- Your auto-steer must have the ability to store and recall an A:B line for a particular paddock.
- Your auto-steer must have a 'nudge' feature in order to move the required distance to go inter row e.g. nudge over 150mm in year 2 if you are on 300mm spacings
- You must keep the same row spacing year-in year-out
- It is preferable to sow in the same direction each year for each run because sowing rigs will crab, but hopefully crab in the same pattern as the previous year.

Selecting your row spacing

There is a growing consensus that 300mm (12inch) row spacing is a good fit for inter-row sowing, yet there are many farmers achieving this result with spacings ranging from 250mm to 375mm. The selection of a desired row spacing for inter-row sowing is determined by the tracking performance of the planter, topography of the farm, likely crop rotations, locations of wheel tracks (in a CTF system), interest in shielded spraying.

Small plot research has found yield penalties occur with wide row spacing (300mm+) when yields exceed 3.5t/ha. However, it should be noted that these trials have not included an inter-row sowing treatment with standing stubble which is a key reason for the increased row spacing.

Farmers moving to a wider row spacing should be doing so with a farming system approach in mind, which will present the need to re-consider agronomic management to ensure yield potential is maintained. Such management decisions are likely to include sowing rates, time of sowing, fertiliser rates and weed control.

Below are results from an on-farm trial near Rokewood, Victoria, where using autosteer the farmer (Troy Missen) was able to compare 375mm and 187.5mm row spacings in wheat. The paired paddock experiment confirmed that despite lower plant numbers for the wider row spacing (182plants/m2 versus 233plants/m2), the plants were able to compensate and equal the yield potential of the narrower row spacing.

Some broadleaf crops (beans, canola, chickpeas, lupins) and to a lesser extent barley, are more suited to wide row cropping because of their ability to extract moisture from their inter row, less fliar disease with a more open canopy, and higher pod height in pulse crops.

No-till, controlled traffic farmer Ben Beck, near Wagga Wagga, NSW has been trialling wide row canola for the past two seasons. In 2009, 750mm canola yielded 471 kg/ha, 375mm yielded 187kg/ha. The two trials were 6ha each with just 187mm growing season rainfall. In 2010, 750mm yielded 2.47t/ha, 375mm yielded 2.26t/ha. This trial was over 97ha and with 400mm growing season rainfall. The wide row plants were visually larger and had more pods per/m.

Photo source: Ben Beck

It is also important to consider the new opportunities presented in a wider row spacing situation such as banded fungicide & foliar spraying, shielded inter-row herbicide applications.

Tyne/disc arrangements

For a two year inter-row cycle you need to off-set the position of the planter ½ row spacing width, this can be achieved by:

- Simply using the nudge or field offset feature on the autosteer, however this increases area of wheel compaction and knocks down standing stubble,
- An off-set hitch can be used to shift the planter however you will need to do the reverse to the aircart to ensure the aircart remains on the wheel tracks and be mindful that an off-set pull may influence the tracking of the implement,
- With raised beds farmers can offset the placement of the planting units on the bar a ¼ of row spacing offset will enable inter-row sowing, as long as the farmer sows in the opposite direction to the following year. Alternatively the planting units can be adjusted each year, but this is quite difficult with most planting bars.

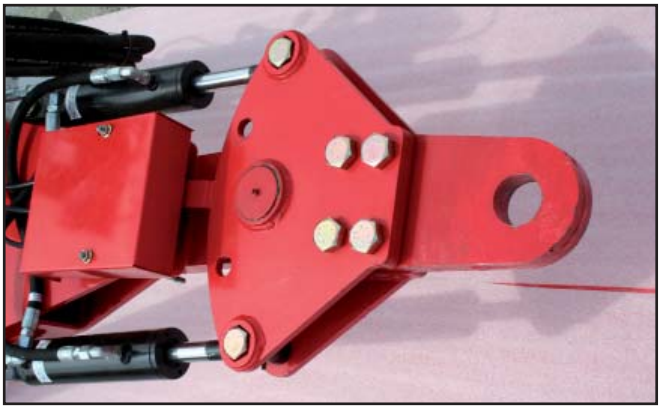
To calculate number of planting units required, divide the effective working with of the planter by the desired row spacing For example: 9.0m planter / 300mm row spacing = 30 planting units

Calculation:

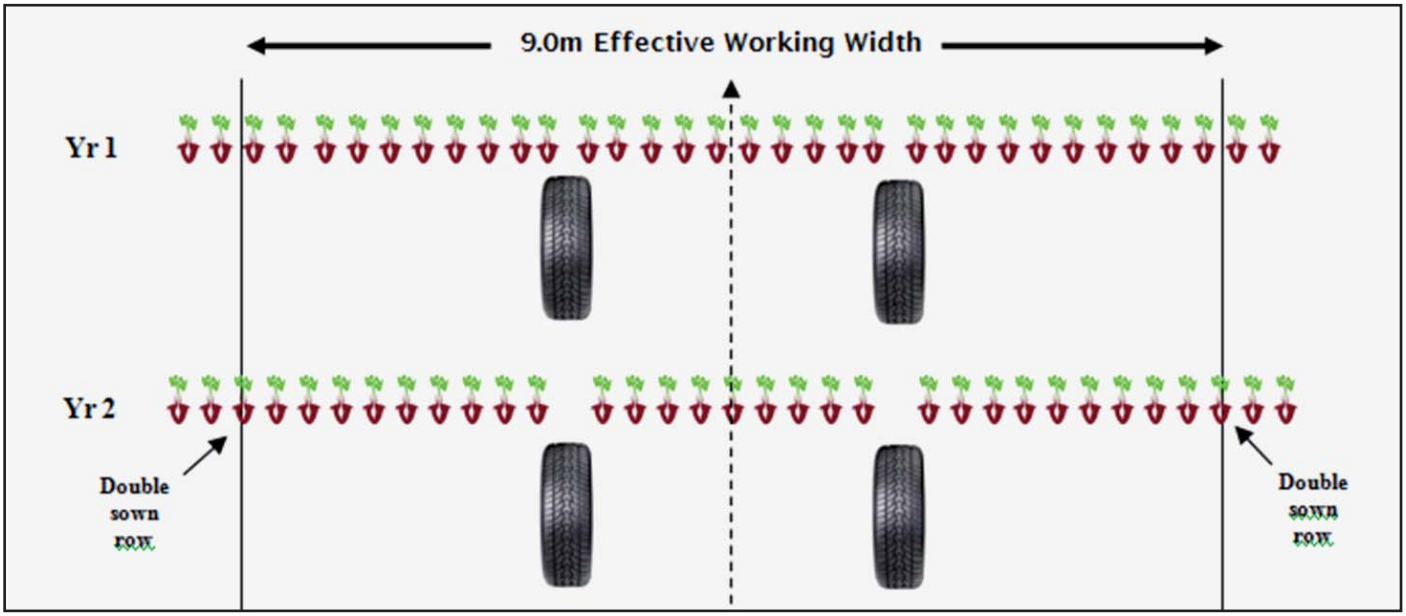
$$\frac{\text{Planter width} \quad \_\_\_\_\_ \text{cm}}{\text{Row spacing} \quad \_\_\_\_\_ \text{cm}} = \_\_\_\_\_ \text{ number of planting units}$$

NB: odd number means there IS a centre planting unit, and even number means there is NO centred planting unit on the bar. Either way the planter load is evenly balanced and there will be a guess row equal to ½ the row spacing on either side of the outside tynes.
Therefore with a 9.0m planter on 300mm row spacing the measurement between the two outer-most planting units will be 8.7m. The effective working width of the planter is 9.0m because you need to allow for the guess rows.

Here are two examples of off-set hitches used to inter-row sow, but without having to nudge the path of the tractor.



Below is an illustration of tyne/disc arrangement on a 9.0m planter and 300mm row spacing, using the combination of an offset hitch plus an extra planting unit. In the second year the planter has 31 planting units, double sowing the outside rows. As mentioned a simpler method is to simply nudge the tractor over to achieve essentially the same result.



Source: Andrew Whitlock

Section 3: Practical Guidelines for Inter-row Sowing

Inter-row sowing is not always easy to implement successfully as many farmers have experienced over the past few seasons with high loads of standing stubble (see photo below). Here are some ideas that can help with the setup of existing equipment and selection of new seeding equipment.

There is an increasing number of no-till planters/seeders on the market, with a push towards single disc seeders for no-till seeding, tyned machines still remain the dominant planter type in Australia. Desirable components of a planter for inter-row sowing include:

- Independent depth control (in preference to frame depth control). This ensures the most consistent seeding depth in a no-till system given the inconsistent nature of the seedbed,
- Row spacing of min 250mm, preferably wider 300mm. This will assist in inter-row sowing, clearance within the frame, and overall stubble flow,
- Under-frame clearance of at least 500mm,
- In-frame/between bar clearance of at least 650mm,
- Frame components to be bolted rather than welded – this will assist in moving planter units within the frame when required for inter-row sowing,
- A coulter can assist with cutting through stubble, as well as assist with minimising soil throw on tyned planters, fluted/wavy coulters are generally preferred to straight coulters,
- Residue managers can be attached to push aside surface crop residue away from path of tynes.
- Poly or exhaust pipe (40-50mm diameter) on tyne shanks (preferably straight shank design) decreases residue build up,

Until we had highly accurate GPS farmers and contractors did not pay much attention to the stability and tracking efficiency of their implements. Now by paying attention to detail and maximising a number of key features on their implements they can ensure they deviate at no more than 5cm to 10cm, leaving plenty of room to inter-row between 300mm rows.

Below is a list of some key factors that impact the tracking ability of implements:

- The wider the implement the worse the tracking, 60+ft implements challenge tracking. A general rule of thumb is that drawbar length should be half the implement width eg. a 9m planter should have a 4.5m drawbar. Longer drawbars give more leverage and better tracking.
- Depth control across the implement is extremely important for good tracking. Independent depth control tines, such as parallelograms, solve this problem. Some parallelogram arrangements only impact on the presswheel/sowing tyne whilst the main ripping tyne is a conventional type spring release mechanism, these are not as effective as a parallelogram that controls both the cultivating and sowing depth.
- Tyne layout is important in that we need to have an even tyne layout, the layout needs to be symmetrical around the centre of the machine to give equal loading left and right.
- Undulating terrain and side slopes make accurate tracking more difficult. Try to work up and down slopes not across slopes. When working across slopes try to work in the same direction each time. Shorter drawbars are probably better if you are working on side slopes.
- Soil type - heavy pulling situations are generally better than light loads because it is more difficult to pull the implement off course when it is under a heavy load.
- Following last years tracks - in every situation the tyne or implement will try to follow the path of least resistance. Make sure you have a wide headland so that you can clearly get straight tracking with the implement out of the ground before you lower the implement.
- Depth of implement means the distance from the front rank of tynes to the rear rank of tynes. Deeper implements will have a greater tendency to skew and follow last years rows.
- Caster (free steering) wheels offer no lateral stability so are less stable. Caster on the front of an implement can often carry a lot of the load especially in heavy pulling situations (because implements tend to rotate forward). So the rear tyres can carry little weight and so offer little stability. Tandem wheels want to run straight and hence offer more lateral stability than single wheels.
- The pull behind seeder box (implement nearer to tractor) will be marginally better for accurate tracking rather than pull between. Pull behind boxes can also load weight on the rear wheels of the implement aiding stability.
- Twin axle boxes where the front axle steers through the pull is by far the best option. On side slopes if the box tries to fall down the slope the pull turns the wheels and point them up the slope thus preventing it pulling the bar down the slope.
- Three point linkage can cause issues if the implement is too big for the tractor then it will easily push the tractor around. It's essential to have some flex in the frame on wide three point linkage implements or have parallelogram type tynes that give independent depth control.

Section 4: Herbicide Management in Heavy Stubbles

Some of the key concerns about moving to a wider row spacing and retaining heavy stubble loads is the risk of increased weed pressure and poor penetration of herbicides onto spraying targets.

Considerations for maximising spray efficacy in heavy stubble conditions:

- Plump nozzle spacing to equal row spacing,
- Nozzle selection,
- Spray height and angle,
- Droplet size, courser being better,
- Water rate, the higher the better,
- Automatic boom height controller to maintain boom height at the desired level above the target – this is critical for drift reduction as a boom operating at 1m above the ground has almost 10 times the potential drift of that operating at 0.5m;
- When possible spraying when weeds are small will improve fallow efficiency and minimise residue levels for sowing,

The efficacy of soil applied herbicides on weeds such as ryegrass is critical for the success of no till farming. High stubble loads (>5t/ha) can compromise herbicide efficacy as highlighted in an experiment at Sandilands, South Australia in 2006. An experiment was established to test the efficacy of Treflan (Trifluralin), Dual (Metalachlor) and Avadex (Tri-allate) on ryegrass in three stubble systems (Burnt, Slashed and Standing). Ryegrass control in standing stubble was significantly better than slashed stubble with all three products used (Table 5). Stubble loads in this trial were 6 t/ha. In the standing treatment, 3 t/ha was actually standing and 3 t/ha was lying on the surface, and in the slashed treatment 6 t/ha was lying on the surface. In 2005 the same trial was established on a site with only 2 t/ha of stubble, and no difference in herbicide products was observed. Therefore, with stubble loads above 2-3 t/ha we expect better herbicide efficacy when stubble is left standing. Major chemical companies agree that the efficacy of soil applied chemicals will be reduced with surface stubble loads greater than 3t/ha.

Table 5. Effect of stubble on ryegrass control at Sandilands 2006

Stubble treatment	% ryegrass control		
	Trifluralin	Metalachlor	Tri-Allate
Burnt	89.3	66.7	38.3
Slashed	29.3	37.3	16.3
Standing	84.3	78.3	51.7
lsd (5%)	17.3	35.3	20.2

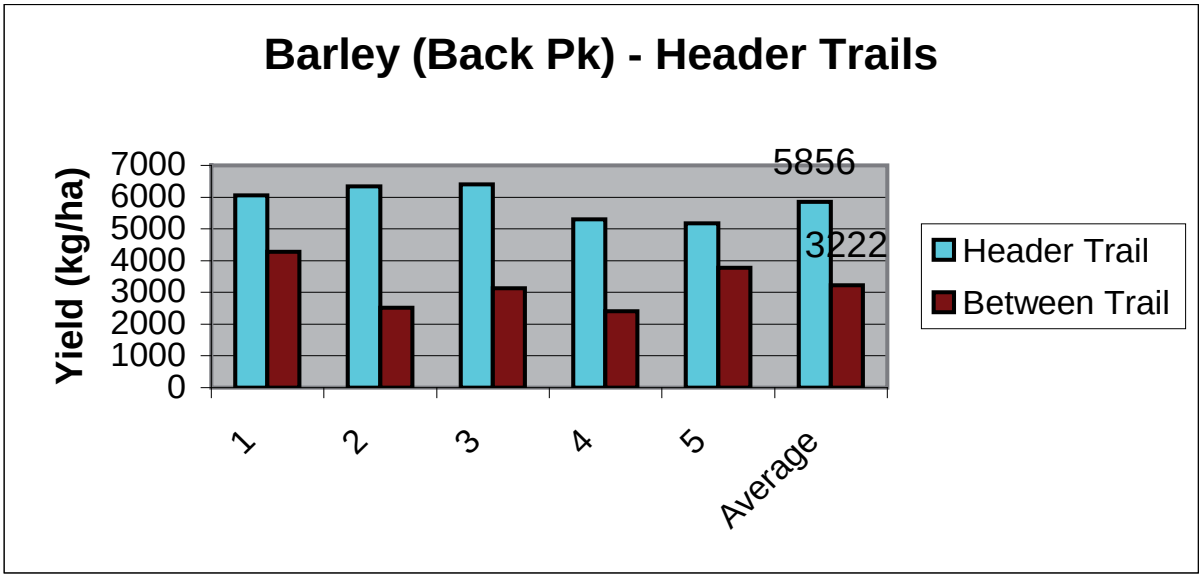
Section 5: Managing Crop Residues at Harvest

Residue management starts with the harvester.

- By cutting stubble tall you reduce the amount of material going through the header, and providing well anchored stubble with an ideal spread pattern. Maximum stubble height will depend upon clearance of the planter, row spacing and the choice of following crop. Sowing into tall stubble after a wet summer which has decomposed at the base, can lead to blockages if there is insufficient clearance within the frame of the planter.
- Many farmers work on the theory that stubble height should not exceed row spacing width to minimise the effect of stubble dragging on tynes,
- Another approach is for the harvester to be set to cut the straw at a height which is 65 percent of the total height of the lowest obstruction of the seeding bar,
- Harvest height should be lowered along headlands and around barriers such as trees in order to assist residue flow at sowing,
- It is extremely important to get short pieces and an even spread of the cut straw and chaff across the full width of the harvester front. Choppers and spreaders are required, they can be retro-fitted to older machines if required increase the power use by 10–20 percent of the harvester's total power.
- The photo below shows very good spreading of the residue. You can see that the spread width is actually wider than the header front (which in this case was 12 metres or 40 feet).

Below (left) is a photo of a 'Cyclone' chaff spreader retro-fitted to a JD tractor and (right) a Claas header factory fitted with a very effective spreader.

- The effects of poorly spread harvest residues (header trails) are often seen in the subsequent crop, The response to this concentration of crop residue will depend upon seasonal conditions and soil nutrient status. Measurements taken from a barley crop near Balliang, Victoria illustrated this point where wheat yield was nearly doubled because of the extra moisture storage and concentration of potassium which was deficient in the soil.



This pattern can be reversed, where the header trails yield less due to a tie up of nitrogen in paddocks with low levels of nitrogen.

- After proper spreading, the next step is to keep the residue standing for inter-row sowing – it is much easier to manage. Stock grazing and other pre-seeding operations (such as spraying) will affect how well the stubble stands up.

Section 6: Crop Management for Wider Row Spacing

As discussed earlier we refer to wider row spacing as 250mm to 375mm. Crop management is always evolving and farmers implementing inter-row sowing generally tend to explore new agronomy and crop rotations such as:

- Early sowing is valuable for promoting crop vigour prior to winter,
- Increased frequency of legume crops in the rotation,
- Wide row (500 – 750mm) crops such as canola, lupins and beans. These crops enable opportunities for banded applications of fungicides and foliar fertilisers, and shielded spraying,
- Relay summer crops become a realistic opportunity,
- Farmers with disc machines have the ability to sow crop directly along a legume stubble to maximise the benefits of nodulated nitrogen,
- Caution needs to be applied with fertiliser rates, especially when single shoot sowing canola into light textured soils,
- Consider cultivars which are more likely to tiller and early nitrogen applications to stimulate early crop growth,
- Nitrogen by soil bacteria is the main nutritional issue with no-till. Whilst the tied-up nitrogen will cycle back to become available again, in the early stages no-till will almost certainly require higher nitrogen rates to be used. The lack of cultivation will also lead to less nitrogen being released from the unavailable nitrogen pool in the soil.

Section 7: Farmer Experiences with Stubble Management

1. Troy Missen (Werneth, Victoria) achieves inter-row sowing whilst remaining on permanent controlled traffic wheel tracks. The excel disc seeder has two different three-point hitch options (below right photo) and the aircart is then offset in the opposite direction using the manual slide attached to the arm (below left photo).

- Troy uses an excel stubble warrior single disc machine on 375mm row spacing. A combination of liquid and granular fertiliser is used at sowing to promote early vigour.
- Legume or summer crops are sowing into tall (400-500mm) wheat stubbles,
- Canola into shorter (200 – 300mm) barley stubbles, or following a legume,
- Burning is reluctantly still an option in proposed canola paddocks where slugs are prevalent.

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2. The Mattschoss family (Sandilands, South Australia) adopted inter row sowing as a method of handling stubbles back in 2004 with good results. From 2004 to 2008 they successfully inter row sowed a variety of crops (cereals, pulses, canola) into stubbles with a 10.5m Flexi-coil 5000 air drill on 225mm spacings and a 2cm RTK autosteer system.

Since 2009 they have adopted a wider row system (375mm) with a 10.5m Daybreak disc seeder, and moved to a 3m controlled traffic system which includes the harvester and sprayer. Stubble management starts at harvest with 50-70% of plant material put through the harvester and stubble height left at approximately 40cm. Chaff and straw is evenly chopped and spread with a factory fitted system that came standard with the harvester. No stubble management is required over the summer period.

Choice of crop type is used to minimise any issues with stubble handling during sowing and subsequent crop establishment e.g. pulses sown on cereal stubble, and cereal and canola crops are sown on pulse stubbles. This results in 50% of their cropping program comprising of pulses, predominantly lentils. Mice, snails and a reduction in herbicide efficacy are significant issues associated with stubble retention, and need careful attention.

Chopper and spreader on the harvester

Stephen Mattschoss in a 8t/ha wheat stubble cut to 40cm

3. The Correll family (Clinton Centre, South Australia) are focused on maximizing machine efficiency during harvest, and manage their cereal stubbles after harvest during the summer period. A stripper front is used to harvest wheat and barley at a speed of 14-16 km/hr, which is approximately twice the travel speed that would be required if they were taking in both straw and grain with an open or draper front. Slasher blades are fitted to the front of the harvester and chaser bin tractor to eliminate the issue of long straw laying on the soil surface under wheel tracks.

After harvest cereal stubbles are mulched with the harvester at 14-16 km/hr. The sieves are closed up, elevator doors kept open and the fan and rotor are run at low speed. Sowing into these mulched stubbles has not been an issue, with coulters on the air seeder bar and sometimes sowing on a slight angle (5-15°) also helping to prevent stubble problems at sowing.

Stripper front used to maximize harvest efficiency

Slasher blades fitted to the front of the harvester

Straw standing 75cm high after harvesting with a stripper front

Straw mulched to a height of 20cm with the harvester post-harvest

Slasher blades fitted to the front of the chaser bin tractor

In conjunction with mulched stubble, coulters in front of tynes on the air seeder bar also help prevent blockages during sowing.

Editors:

Jon Midwood, Southern Farming Systems

Paul Birbeck, Vaderstad

Andrew Whitlock, PrecisionAgriculture.com.au

Matthew McCallum, McCallum Agribusiness Consulting

Contributions from:

Brendan Williams, GPSag

Tim Neale, PrecisionAgriculture.com.au

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Notes

Notes

The information provided in this booklet is general in nature and should not be treated as specific advice. Seek further information from local sources prior to implementing change.

VÄDERSTAD Pty Ltd.

P. O. Box 9075, Cleveland DC,
QLD. 4163. Australia.
Tel: 07 3821 2681 • Fax: 07 3821 6178
email: infoAU@vaderstad.com
www.vaderstad.com

Distributor: